

# Hazardous Weather Testbed: 2012 Activities and Looking Forward

Lans P. Rothfusz (~~Presenter~~ Messenger)

## **Real work done by:**

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# Overview

- The HWT
- Recap of 2012 Activities
- Planned HWT 2013 Activities
- Beyond 2013

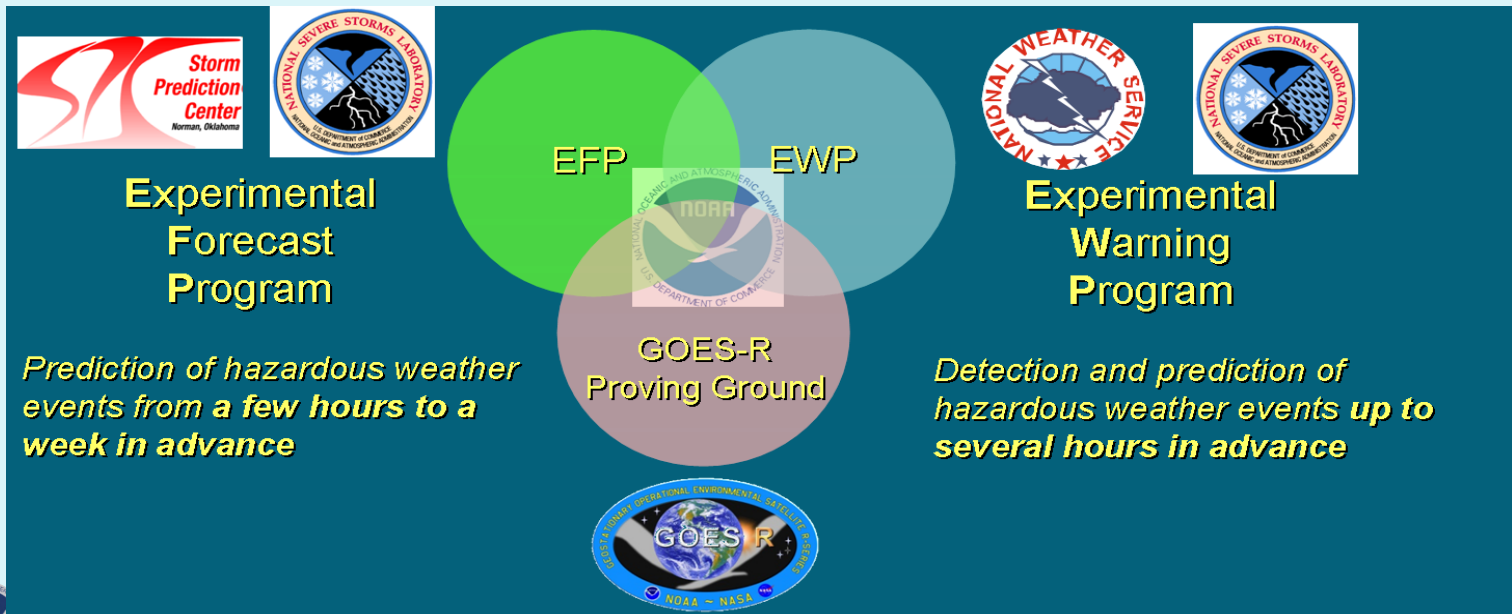


# What is the HWT?

*Not just a facility...*

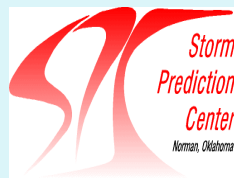


*...but an organization:*



# 2012 Spring Forecasting Experiment

## Experimental Forecast Program (EFP) Activities

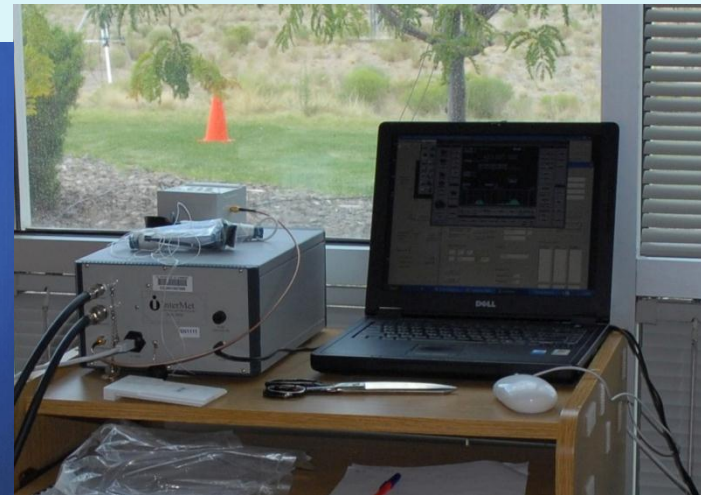


# Evaluation: Experimental Observing Systems

## 1. Radiometrics Passive Microwave Radiometer



## 2. *InterMet Systems* GPS radiosonde system

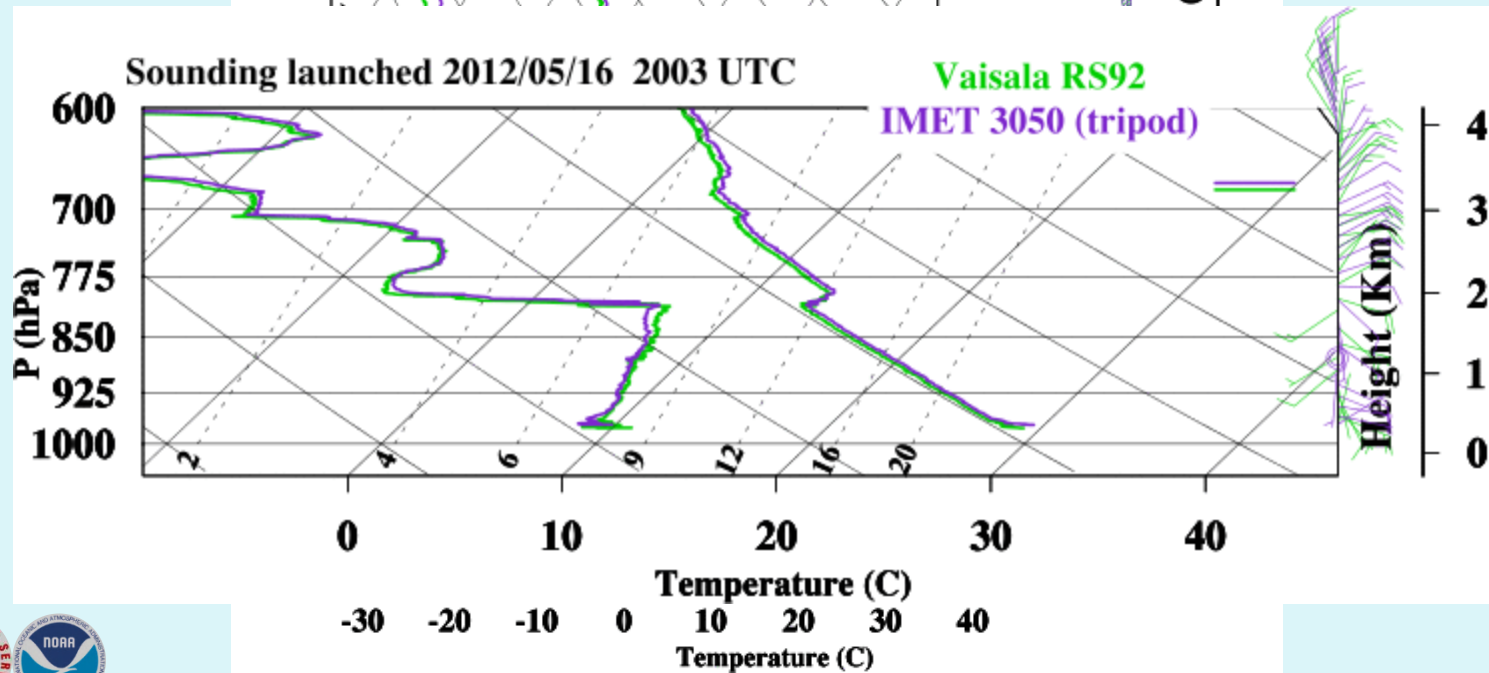
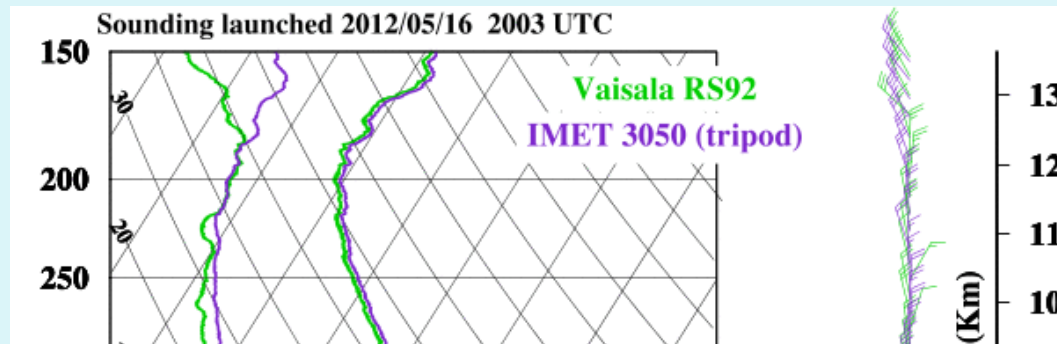


AMS 2013 Conference poster #136 by Coniglio et al.

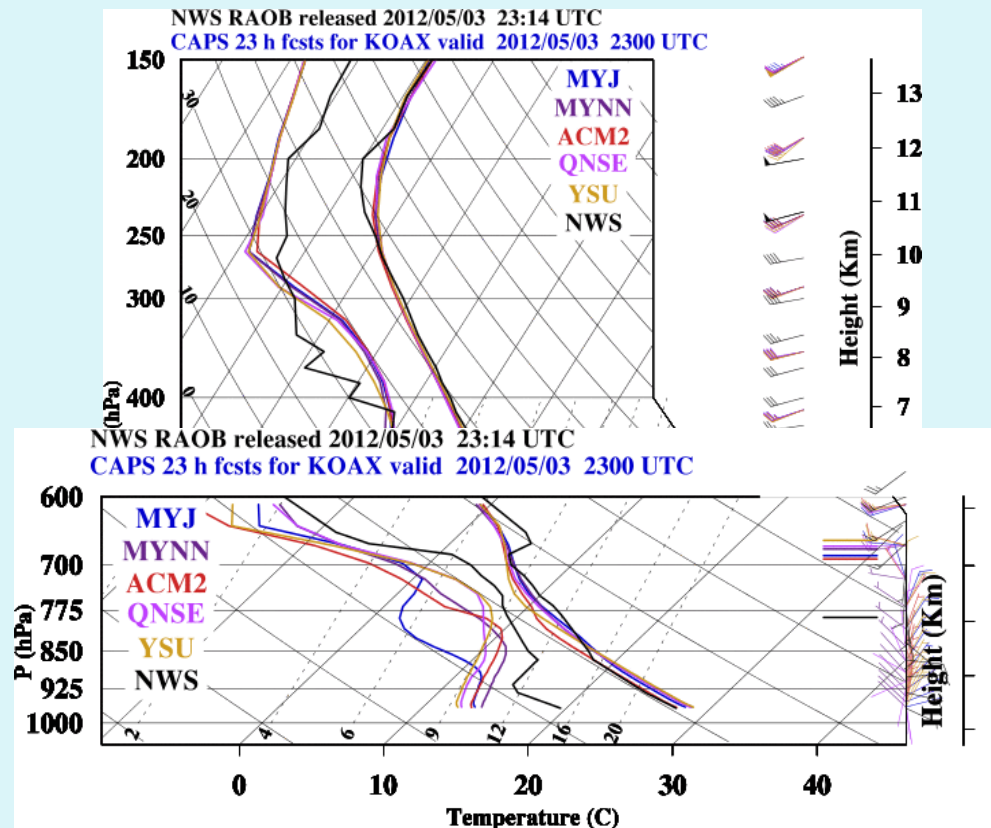




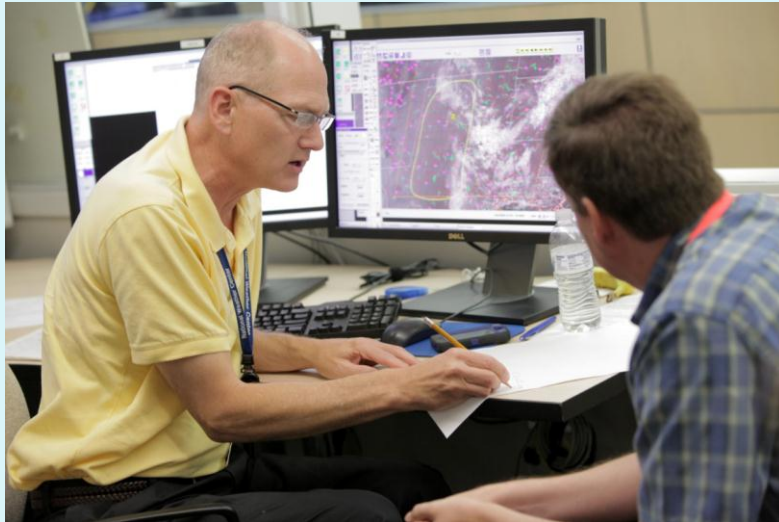
# Evaluation: IMET vs. Vaisala radiosondes



# Evaluation: Sensitivity of sounding structure to PBL parameterization



# Experimental Forecasts: Overall emphasis on timing...



Convective Initiation



Severe Convection





# Experimental Forecasts: OU/CAPS Ensemble System

- 28 member
- 4-km
- CONUS-scale

Member	IC	BC	Microphy	LSM	PBL
arw_cn	00Z ARPSa	00Z NAMf	Thompson	Noah	MYJ
arw_c0 (18h)	00Z ARPSa	00Z NAMf	Thompson	Noah	MYJ
arw_m3	+ em-p1_pert	em-p1	Morrison	RUC	YSU
arw_m4	+ nmm-n2_pert	nmm-n2	Morrison	Noah	MYJ
arw_m5	+ em-n2_pert	em-n2	Thompson	Noah	ACM2
arw_m6	+ rsm-n2_pert	rsm-n2	M-Y	RUC	ACM2
arw_m7	+ nmm-p1_pert	nmm-p1	WDM6	Noah	MYNN
arw_m8	+ rsm-p1_pert	rsm-p1	WDM6	RUC	MYJ
arw_m9	- etaKF-n1_pert	etaKF-n1	M-Y	RUC	YSU
arw_m10	+ etaKF-p1_pert	etaKF-p1	WDM6	Noah	QNSE
arw_m11	- etaBMJ-n1_pert	etaBMJ-n1	M-Y	Noah	MYNN
arw_m12	00Z ARPSa	00Z NAMf	Thompson	Noah	MYNN
arw_m13	00Z ARPSa	00Z NAMf	Thompson	Noah	ACM2
arw_m14	00Z ARPSa	00Z NAMf	M-Y	Noah	MYJ
arw_m15	00Z ARPSa	00Z NAMf	Morrison	Noah	MYJ
arw_m16	00Z ARPSa	00Z NAMf	WDM6	Noah	MYJ
arw_m17	00Z ARPSa	00Z NAMf	Thompson	Noah	QNSE
arw_m18	00Z ARPSa	00Z NAMf	Thompson	Noah	YSU
arw_m19*	00Z ARPSa	00Z NAMf	Thompson	Noah	MYJ
arw_m20*	+ em-p1_pert	em-p1	Morrison	RUC	YSU
arw_m21*	- rsm-n2_pert	rsm-n2	M-Y	RUC	ACM2
arw_m22*	+ rsm-p1_pert	rsm-p1	WDM6	RUC	MYJ
arw_m23*	+ etaKF-p1_pert	etaKF-p1	WDM6	Noah	QNSE
nmm_cn	00Z ARPSa	00Z NAMf	Ferrier+	Noah	MYJ
arps_cn	00Z ARPSa	00Z NAMf	Lin	force-restore	force-restore
cmps_cn	00Z ARPSa	00Z NAMf	Hobbs-Rutledge	?	?
cmps_c1	00Z ARPSa	00Z NAMf	M-Y	?	?
cmps_c0	00Z ARPSa	00Z NAMf	Hobbs-Rutledge	?	?



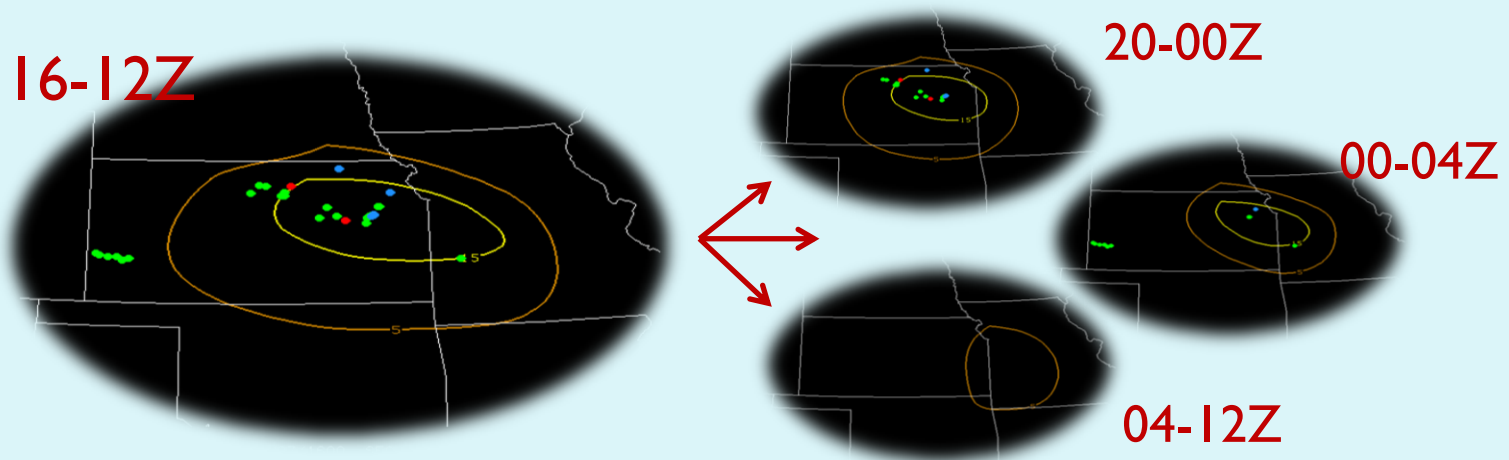
AMS 2013 Conference poster # 138 by Fanyou Kong et al.

# Experimental Forecasts: Severe Convection

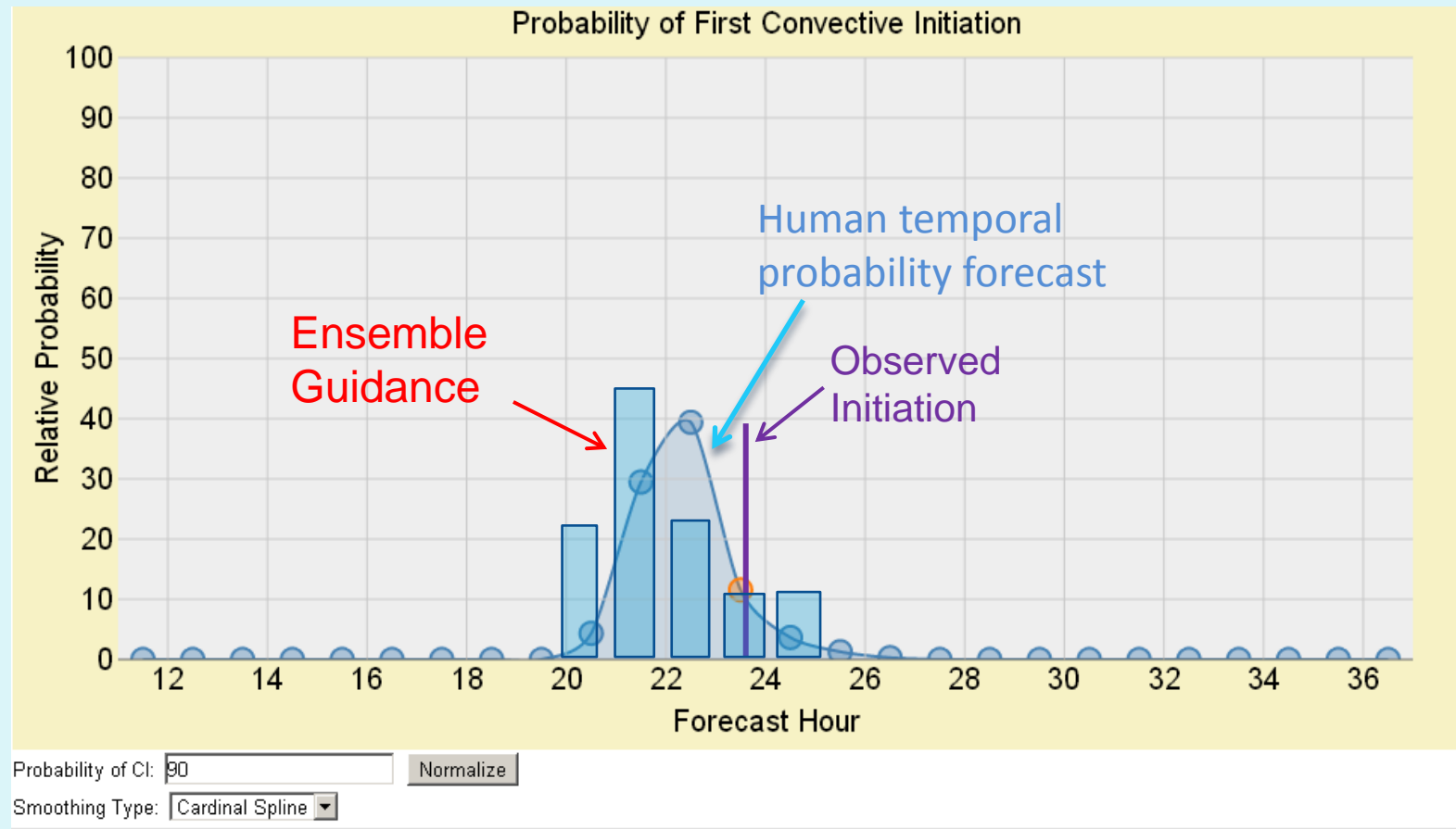
Automated “*temporal disaggregation*” of SPC Convective Outlooks

**Input**: long period probabilistic human forecast + “surrogate severe” diagnostics from high-resolution ensemble

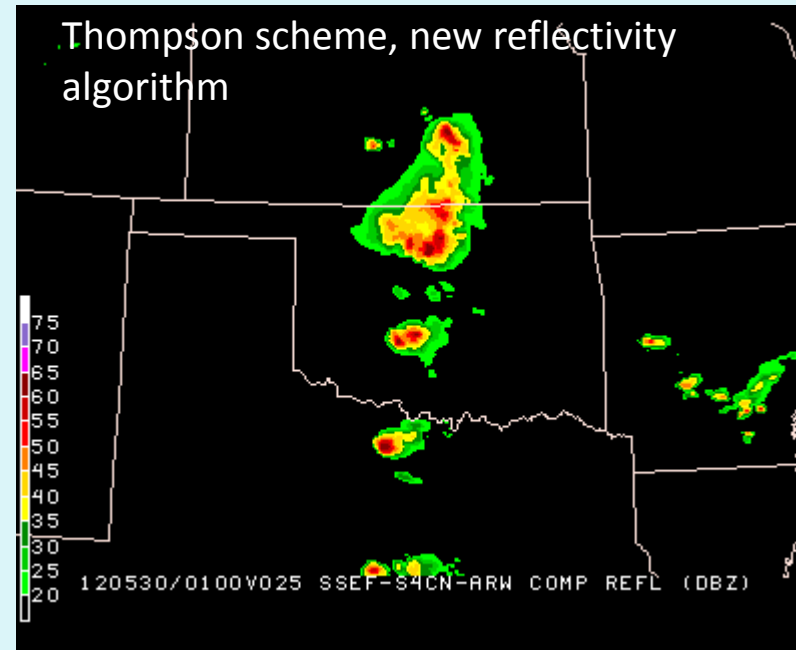
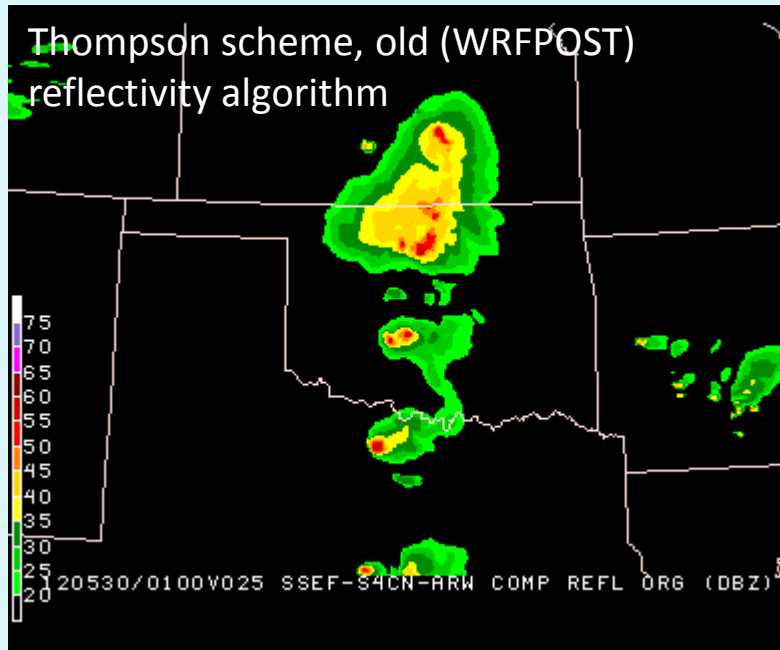
**Output**: Multiple shorter period probabilistic forecasts



# Experimental Forecasts: Probability of Convection and CI



# Evaluation: Microphysics, Sensitivity to Reflectivity Algorithm



*Many thanks to Greg Thompson...  
plus Hugh Morrison, Jimmy Dudhia, Song-You Hong, Kyo-Sun Lim*



# 2012 Spring Forecasting Experiment

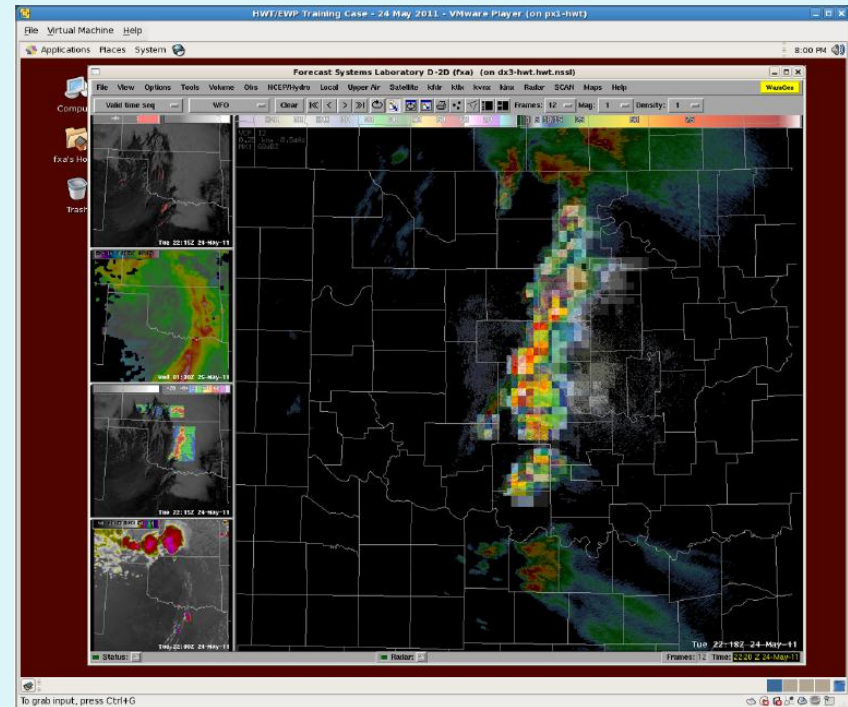
## Experimental Warning Program (EWP) Activities





# EWP 2012 Spring Experiment

- Operations
  - 7 May - 11 June.
  - 4-6 visiting forecasters/week (compare to EFP mostly from SPC and research community).
- Training
  - Product training prior to arrival (new)
    - Leveraged NWS Weather Event Simulator (WES).
    - Allowed full ops on Monday.

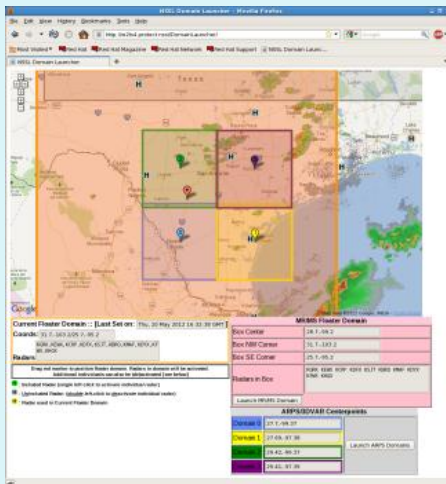


**Virtual WES technology and training gave participants exposure to products offsite**

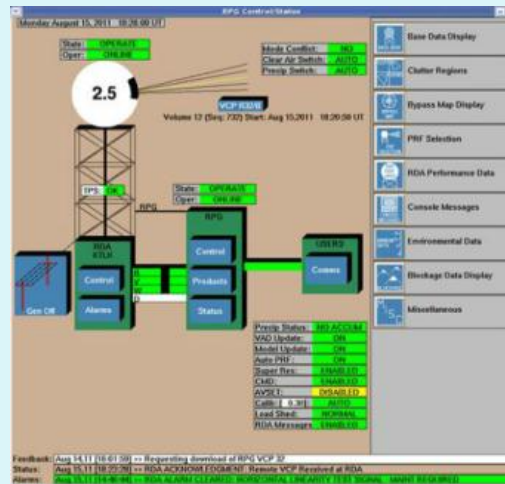
# New in 2012: AWIPS-II

- NWS's next-generation operational forecasting platform.
- Familiar environment for forecasters to evaluate datasets and issue warnings via WarnGen.

## Additional Features:



**Domain Manager for  
Subsetting Experiential  
Datasets**



**10 Floating Radar Product  
Generators for Level-III  
Data Generation**



**Flexible Environment Allowing  
Any WFO to be Used in Operations**

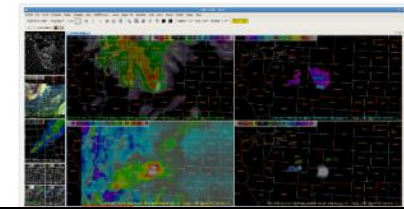
# Receiving Feedback

- Live-Blogging
  - Forecasters provided warning decision-making thoughts and images in real-time.
- Surveys
  - Forecasters providing feedback on the strengths/weaknesses of the products.
- Daily/Weekly Debriefs
  - Dedicated face-to-face time between forecasters and developers on the evaluated products.

## Supercell E of Pueblo (Colorado)

Wednesday, May 23rd, 2012

Well anticipated by OUNWRF, strong to severe storms formed over E-C Colorado (here E of Pueblo) by 0030 Z. This is the latest forecast for 0200Z, showing the supercell moving straight to the east.



» April 2008

### Categories

- » Area Forecast Discussion (AFD) (7)
- » Daily Summaries (75)
- » Experimental Warning Thoughts (19)
- » Forecaster Thoughts (38)
- » General (70)
- » Lightning Jump Algorithm (14)
- » Live Blogs (673)
- » Operations Status Messages (17)
- » Outlooks (80)
- » WAS\*IS (1)
- » Webinars (2)
- » Weekly Summaries (33)

## EWP 2012 - HWT Spring Experiment

pGLM Total Lightning Data Product Evaluation

**What were the strengths and weaknesses of the lightning data during this particular event?**

**What particular products (e.g., pGLM flash extent density, 60 min or 120 tracks) did you like or find useful? Why?**

**What features and individual products did you NOT like or would change (and how would you envision them changing)?**

**How do you envision using total lightning data in the future? What other thunderstorm modes and cases would you like to see examples of?**

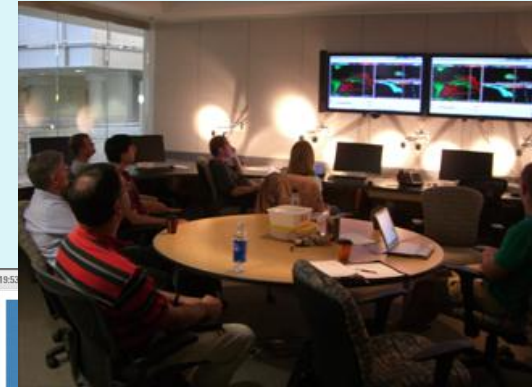
**Did any ideas or suggestions arise from using the existing products?**

**What was your overall impression?**



# Receiving Feedback: “Tales from the Testbed”

- A webinar summary of each week's experiences
- Presented by NWS participants.
- Facilitated by the NWS Warning Decision Training Branch (WDTB).
- Archived webinars available.



HWT Tales from the Testbed (Week 3) (19:53)

HWT Week 3 Participants

Outline Thumbnails Notes Search

- 13. "Foot Stomper"
- 14. Andy Kleinmeyer (WRF Simulated GOES)
- 15. Main Message
- 16. WRF Simulated GOES-R, 5/21 20 UTC
- 17. WRF Simulated GOES-R, 5/22 20 UTC
- 18. UW CIMSS GOES Nearcast, 5/24 2030
- 19. "Foot Stomper"
- 20. Chris McKinney (3DVAR)
- 21. Main Message
- 22. 3DVAR Right Turn
- 23. 3DVAR Example #2
- 24. 3DVAR Example #3
- 25. "Foot Stomper"
- 26. Gordon Strassberg (CICTC)
- 27. UAH-CI and UW-CTC
- 28. CICTC Example #1
- 29. CICTC Example #2

3DVAR output (clockwise from top left – max storm top divergence, updraft helicity, max updraft, max vorticity) and associated severe thunderstorm warning in southeastern Minnesota.

articulatee  
Powered by Articulate

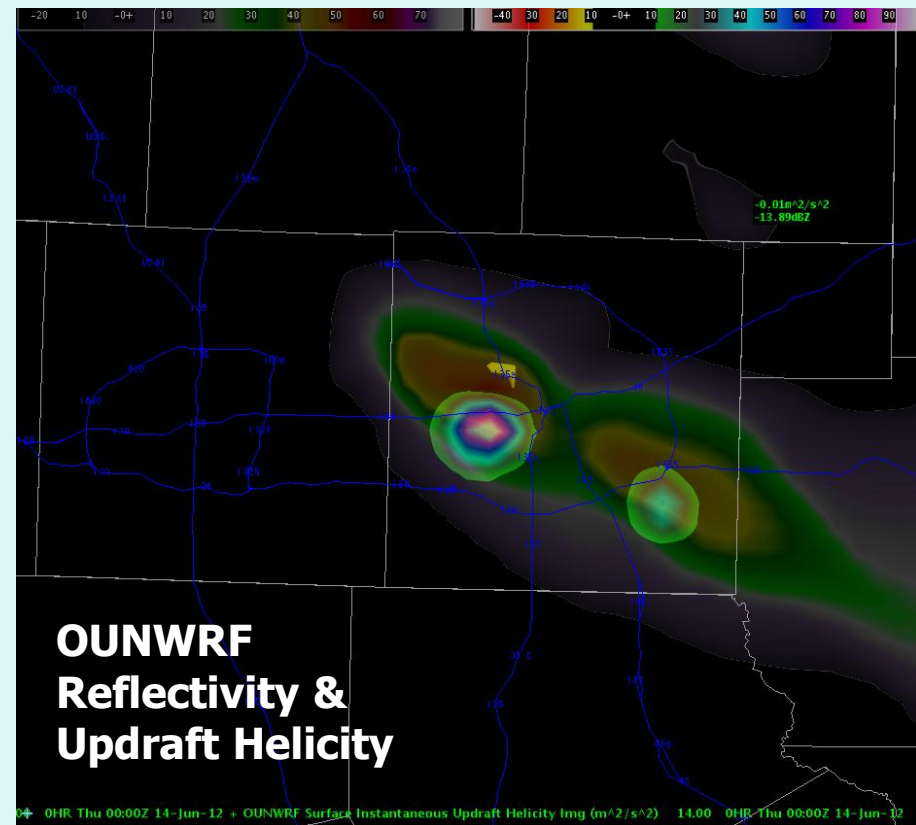
SLIDE 24 OF 33 PAUSED 00:05 / 03:02

**Articulate Web Briefing**



# EWP 2012 Projects: OUN-WRF

- High frequency (15 min. output), high resolution (3km) local model
- Products Evaluated:
  - 1km/Composite Reflectivity.
  - Maximum/hourly updraft helicity.
  - Hourly column hail.
  - 10m wind speed.

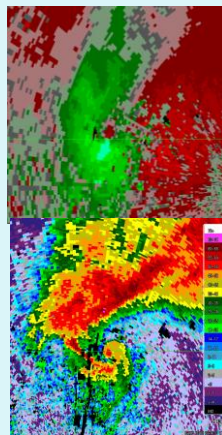




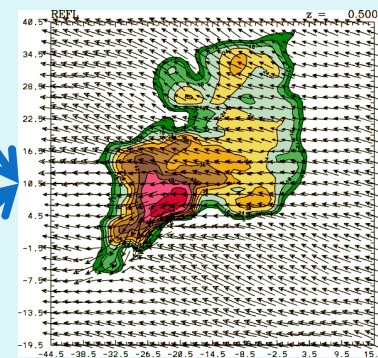
# EWP 2012 Projects: 3DVAR

- Combine multi-sensor data with numerical models in a physically realistic manner.
- Products Evaluated:
  - 3D wind fields
  - Simulated reflectivity
  - Updraft strength
  - Updraft helicity
  - Divergence aloft
  - Vorticity.

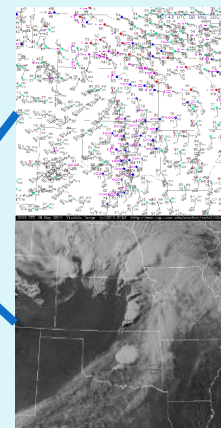
**Multi-Radar**



**3DVAR Output**

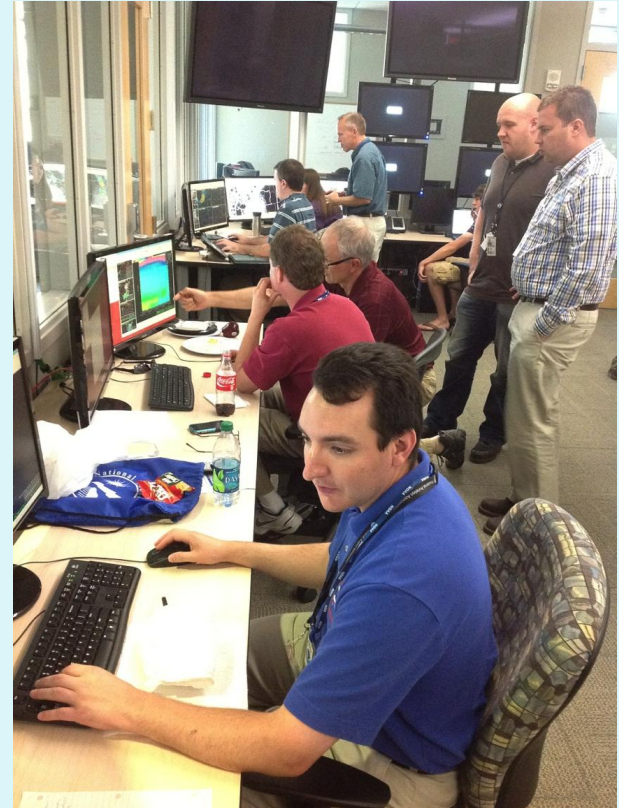


**Multi-Sensor & Models**



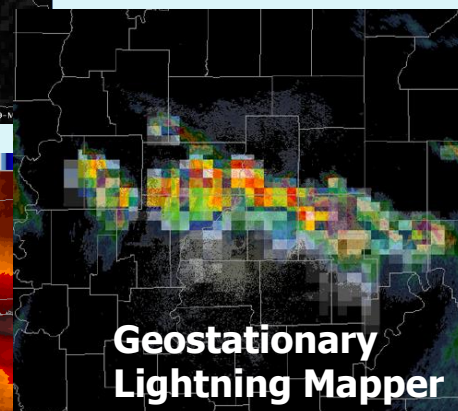
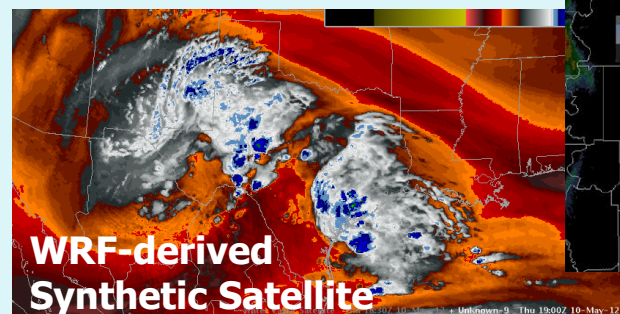
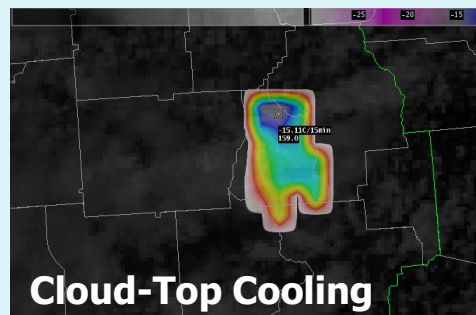
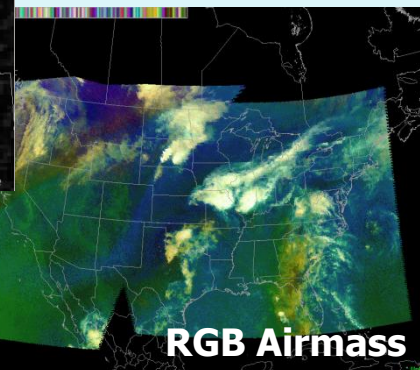
# Forecaster Feedback: 3DVAR

- Favorite products:
  - Updraft & vertical vorticity.
  - Storm-top divergence.
- Real-Time Data Issues:
  - Data latency (approx 5 min).
  - Distance from radar (lack of low-level input).
  - Bad data quality leads to bad 3DVAR side lobe contamination, improper dealiasing.
- Feedback...
  - Useful when “trying to diagnose a large number of storms” and “sitting on the fence” (about issuing a warning).
  - More “efficient to view than existing algorithms” to diagnosis storm intensity and rotation.



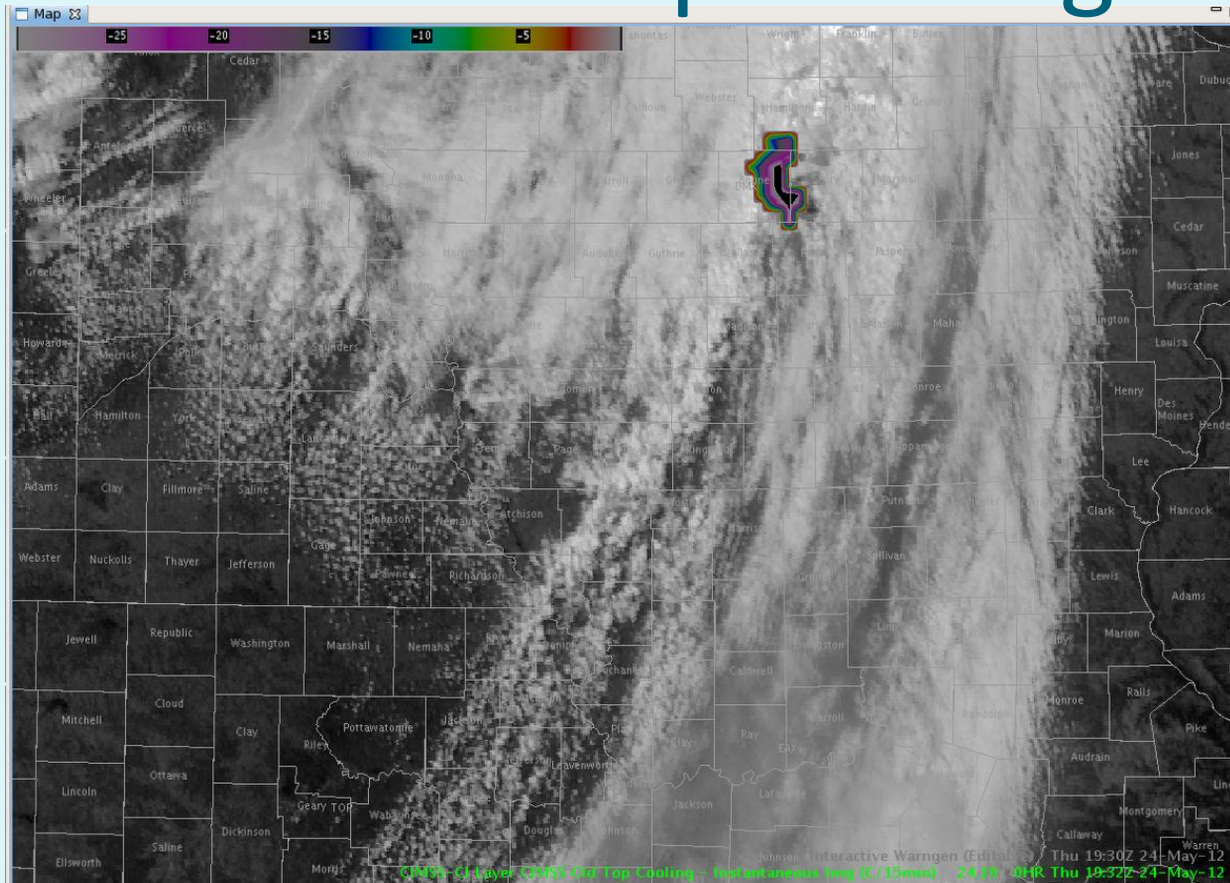
# EWP 2012 Projects: GOES-R

- GOES-R Products
  - Baseline and future products to determine readiness before satellite launch.
- Products Evaluated:
  - Convective Initiation
  - Convective Nearcasting
  - Cloud-Top Cooling
  - Lightning Detection (pGLM)
  - Sounder RGB Airmass
  - WRF-derived Synthetic Satellite





# GOES-R: Cloud-Top Cooling Rate



“The cloud top cooling product in central Iowa indicated nearly 40 C/15 km of cloud top cooling for a storm in Boone and Story counties. **This product preceded intense radar reflectivity in the area by nearly an hour.**” –NWS Forecaster, Week 3



More research (providing solid statistics) should be done to determine the appropriate cooling rate values that are associated with the occurrence of severe weather.

“Strong CTC signals off the terrain in NM with little or no convective development... Take home point — **this is a great product, however forecasters need to know their environment to use this product in enhanced warning ops and beware of times that the convection is being forced by the terrain...** the sfc dwpts were in the teens and lower 20s. Almost no way convection could develop with this dry air.”

NWS Forecaster, *“[ABQ: CTC + Situational Awareness = Great Fcst](#)”, Realtime-Blog*

“Based on the environment and the ongoing supercell activity, I issued the warning as soon as I saw the CTC... **Without the CTC product, I may have issued the warning a scan or two later...**”

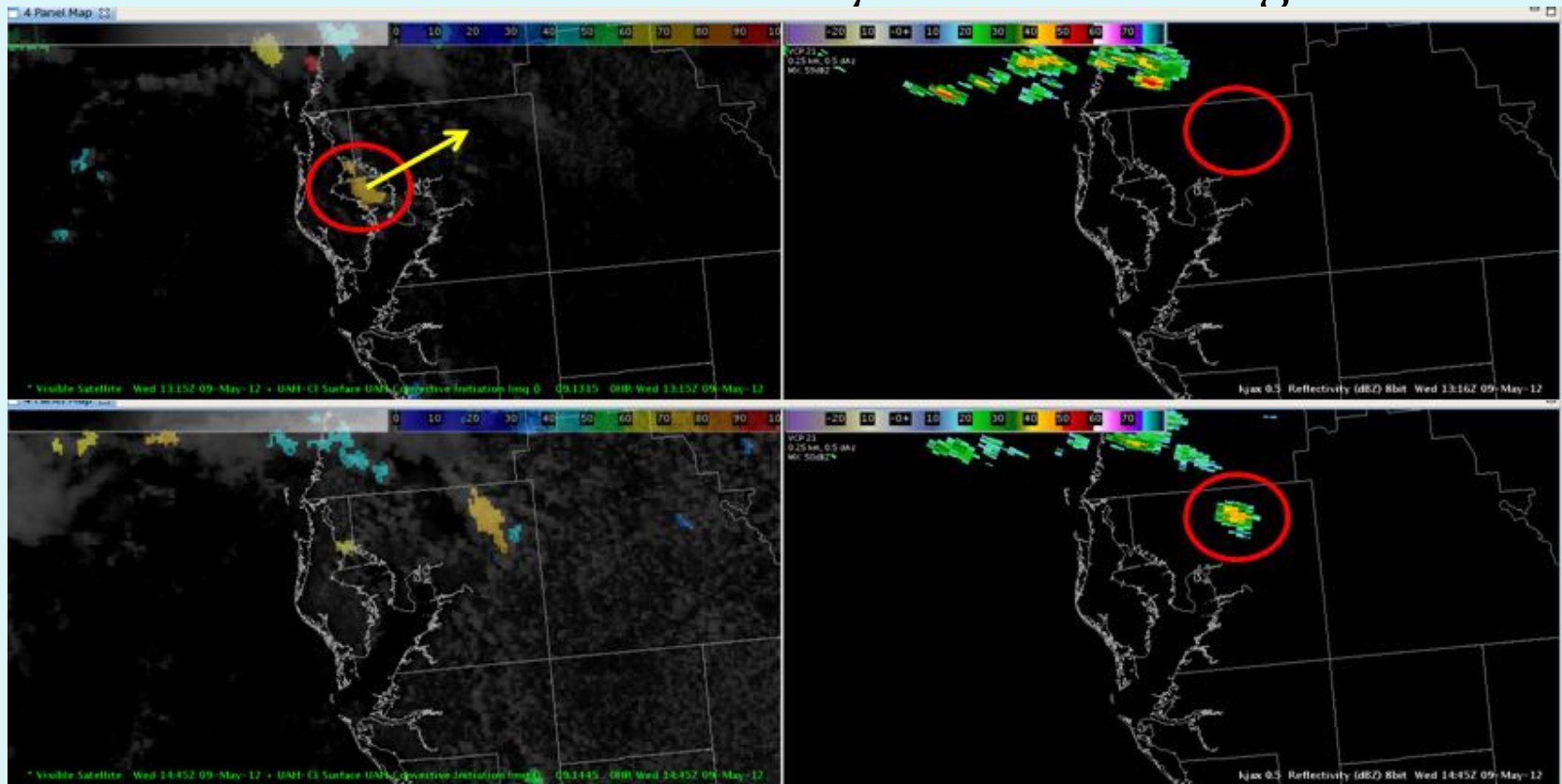
NWS Forecaster, *“[Tales from the Testbed](#)” Webinar, 11 May 2012*





# GOES-R: Convection Initiation w/Satcast

- Satellite Based Convection Analysis and Tracking



Strength of Signal CI product produces forecast output of 70+ index value (on scale from 0-100), valid from 1315 UTC (Left). Storm motion to the ENE. By 1445 UTC (1.5 hours after the above CI forecast in Figure 1), the first 35+ dBZ echo is finally detected by the radar (Right).

100% of the forecasters responded “yes” in the survey when asked if they preferred a probabilistic approach to a binary yes/no approach.

“The SATCAST strength of signal is a **huge improvement.**”

NWS Forecaster, *[EWP end of week 2 debrief](#)*

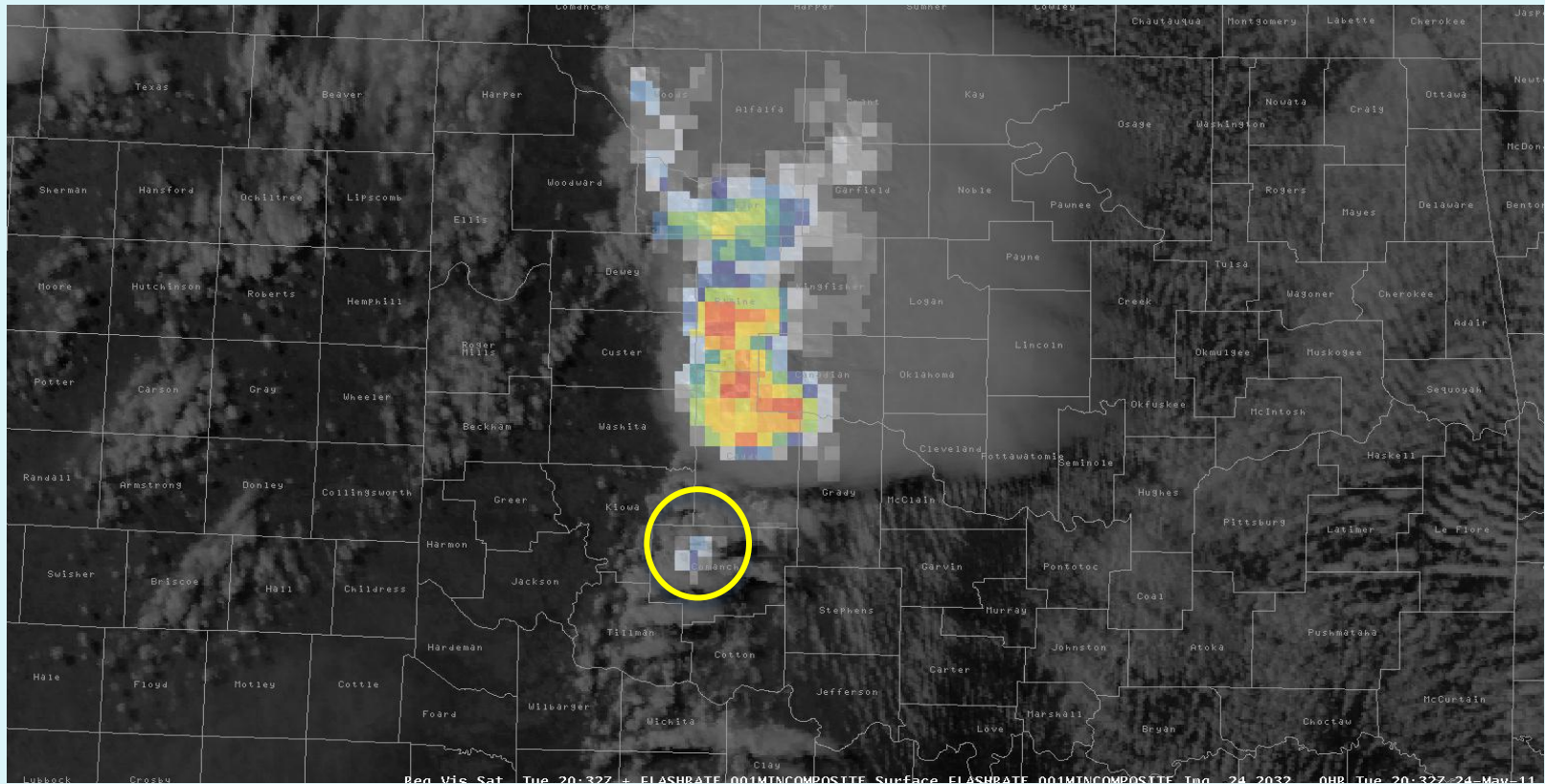
“The probabilistic CI will be **really useful for aviation purposes** since we're not looking at just severe convection.”

NWS Forecaster *[EWP end of week 3 debrief](#)*





# GOES-R: Psuedo-Geostationary Lightning Mapper (pGLM)



## Anvil extent & convection initiation



pGLM is a great situational awareness tool and can provide more confidence in a warning decision.

**“Total lightning data preceded the CG network anywhere from 10-40 minutes.** I was able to quickly determine when flash rate was significantly increasing, and then compare with satellite and (3DVAR) updraft/downdraft parameters for a nice big picture.”

*NWS Forecaster, Post Event Survey*

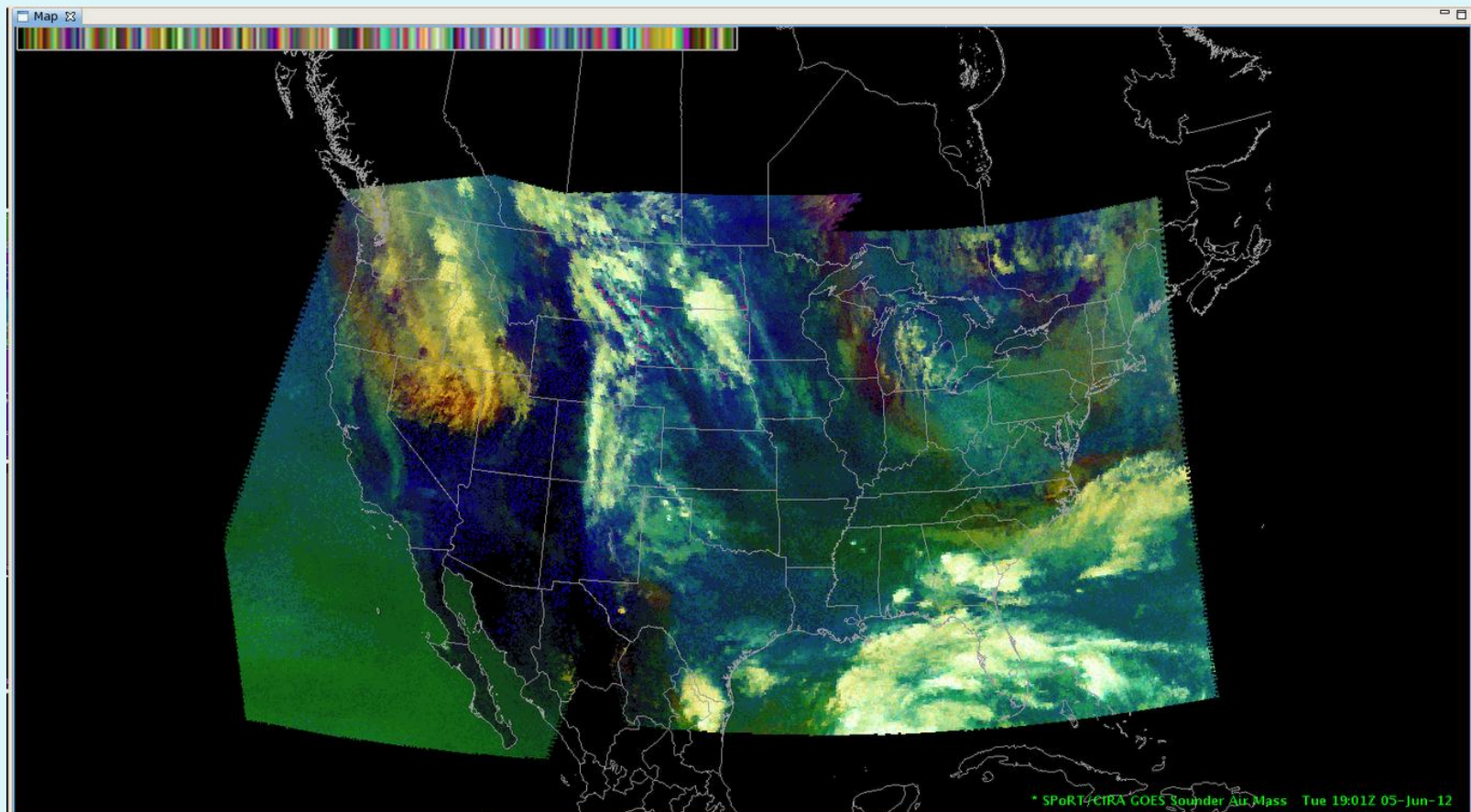
“Coming into the day, I wasn't quite sure when or where to or why to use the data, but after using it I really think it has a lot of functionality and is useful in warning operations. **I look forward to it as a product from the GOES-R.**”

*NWS Forecaster, Post Event Survey*





# GOES Sounder Airmass RGB



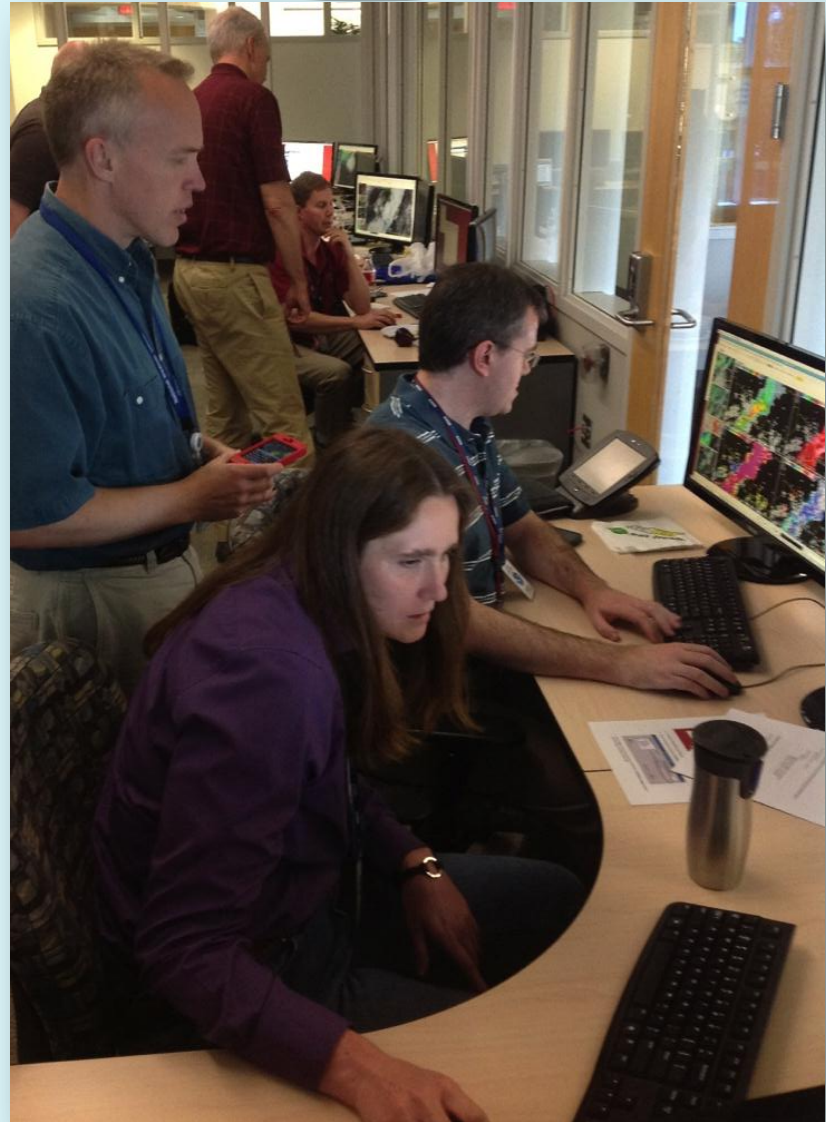
GOES Sounder RGB Airmass product displayed on HWT AWIPS II workstation at 1901 UTC on 5 June 2012.



Provides a quick look at the synoptic scale atmosphere, as well as an innovative way to display satellite imagery ...

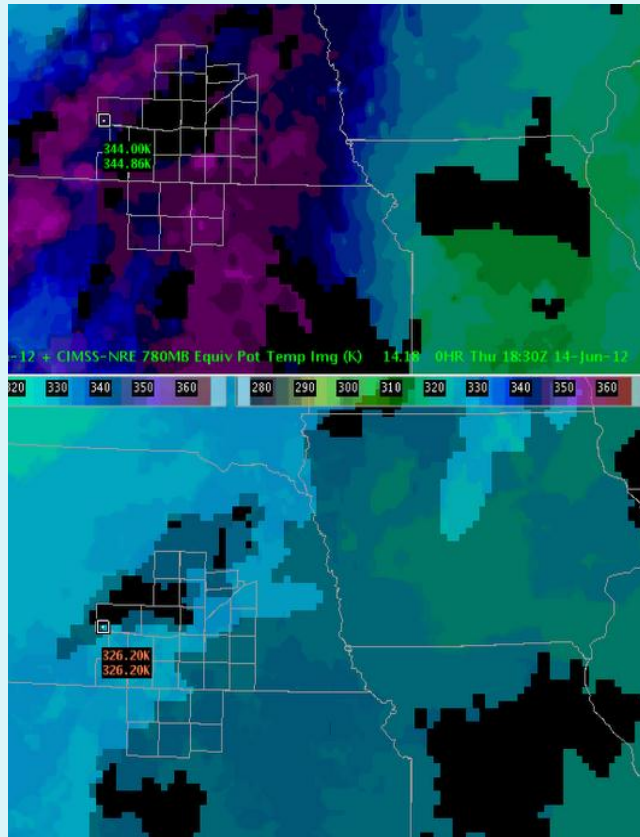
“It was **interesting to see the initiation occurred along the sharp moisture gradients that were associated with the strong shortwave troughs...** as well as being very useful for picking out the jet maximum... I really love this product.”

NWS Forecaster, *EWP end of week 3 debrief*

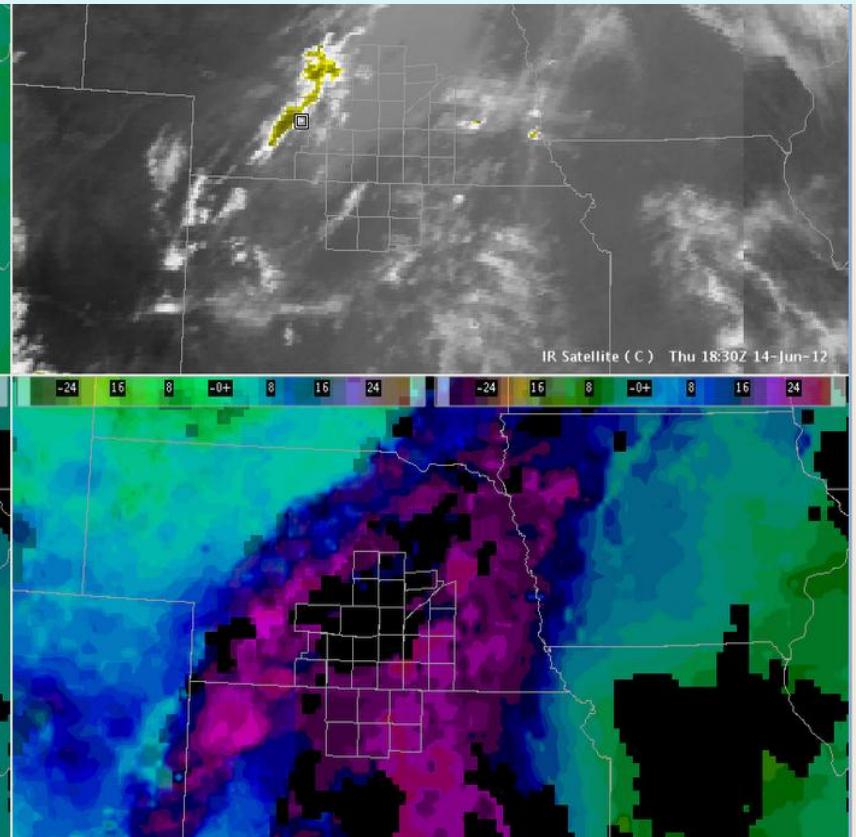


# Nearcast

**GOES-E and GOES-W  
Nearcast low-level theta-e**



**GOES-E observed IR**



**Mid-level theta-e**

**Theta-e difference**





Forecasters found the NEARCAST products particularly useful in determining convective maintenance.

“It was telling us that **the axis of instability was going all the way to the coast (and it did) and that would be a huge thing to know**, whether the convection would continue or die.”

NWS Forecaster, “[\*EWP daily debrief 6/12\*](#),”

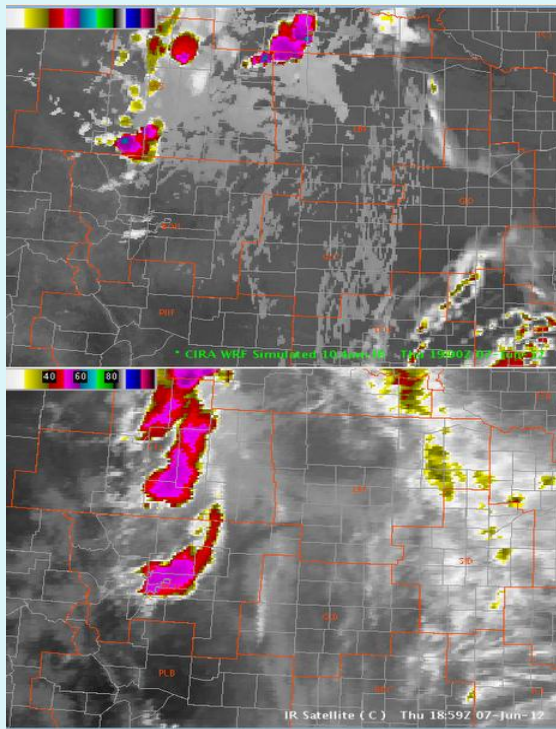
“On the boundary of the GOES-E and GOES-W domains, it would be nice to have some continuity from one product to the other.”

NWS Forecaster, [\*Final EWP weekly debrief\*](#)

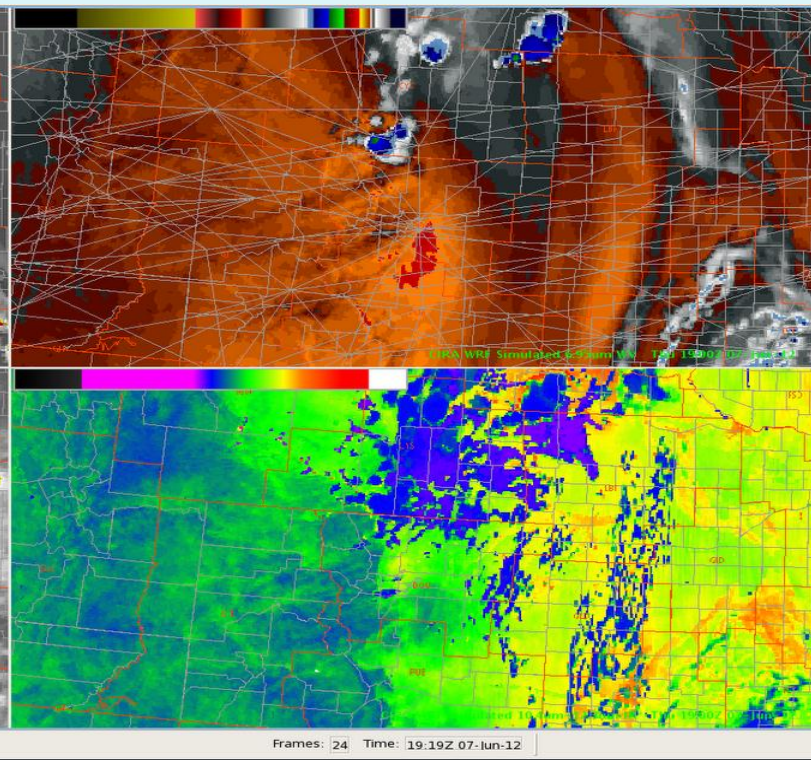


# NSSL-WRF: Simulated Satellite (Cloud and Moisture Imagery)

**NSSL-WRF FORECAST (SIM) IR  
FOR 1900 UTC**



**SIM WV (6.95  $\mu$ m) AT 1900 UTC**



**ACTUAL IR SAT AT 1900 UTC**

**SIM BAND DIFFERENCE (10.35-12.30  $\mu$ m) IR AT 1900 UTC**



Forecasters were very excited about the simulated satellite imagery and would like to have it provided within their operations.

“I was **really impressed on how well it picked up on the whole pattern, convective initiation and location**... the purpose is to get a whole 3D representation and I liked that aspect.”

NWS Forecaster, *[“EWP daily debrief 5/9](#)*

“**Synthetic WRF imagery can enhance forecasts** by providing model data in a familiar satellite format which makes model analysis, model comparison to obs and model forecast projections easier to visualize and understand.”

NWS Forecaster, *[“Tales From the Testbed” Webinar, 11 May 2012](#)*





# Phased Array Radar Innovative Sensing Experiment (PARISE)

## Objective

*Explore how improved depictions of storm development from rapid sampling may benefit forecasters' decision-making processes.*



# A Look Back: 2010



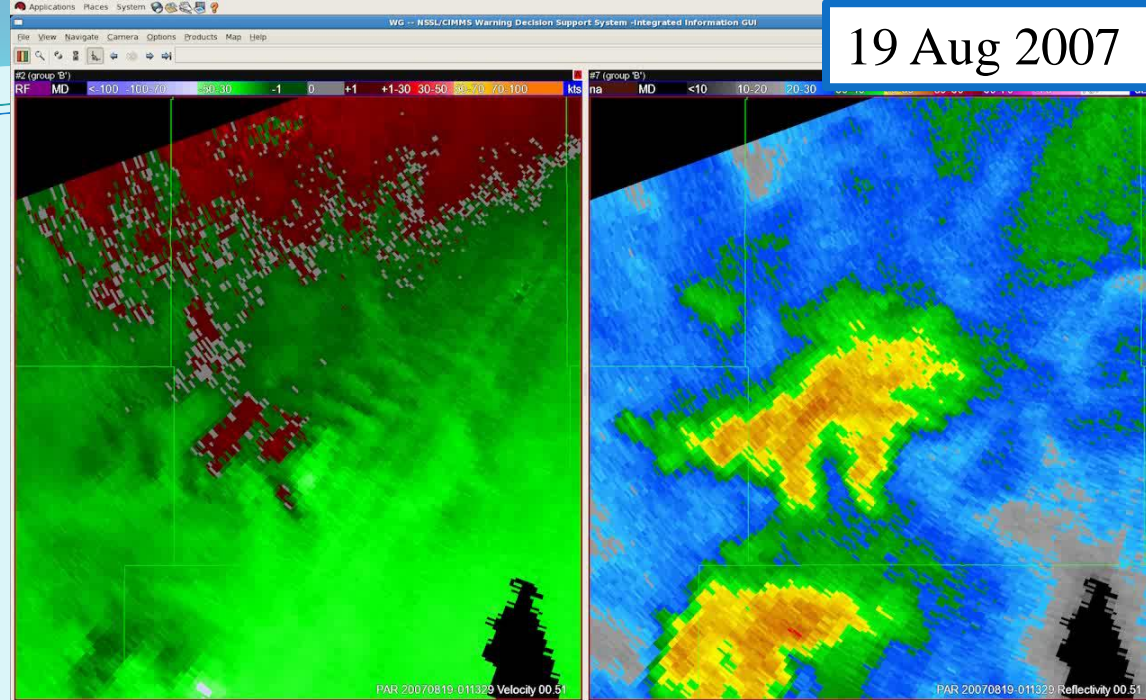
## PHASED-ARRAY RADAR Innovative Sensing Experiment

- 12 forecasters
- Temporal Resolution Experiment
  - Paired forecasters w/ similar radar analysis skills.
  - Worked tropical supercell event that produced EF1 tornado (unwarned).
    - **Pair 1: 43-s updates**
    - **Pair 2: 4.5-min updates**
- Heinselman et al. (2012) Wea. Forecasting.

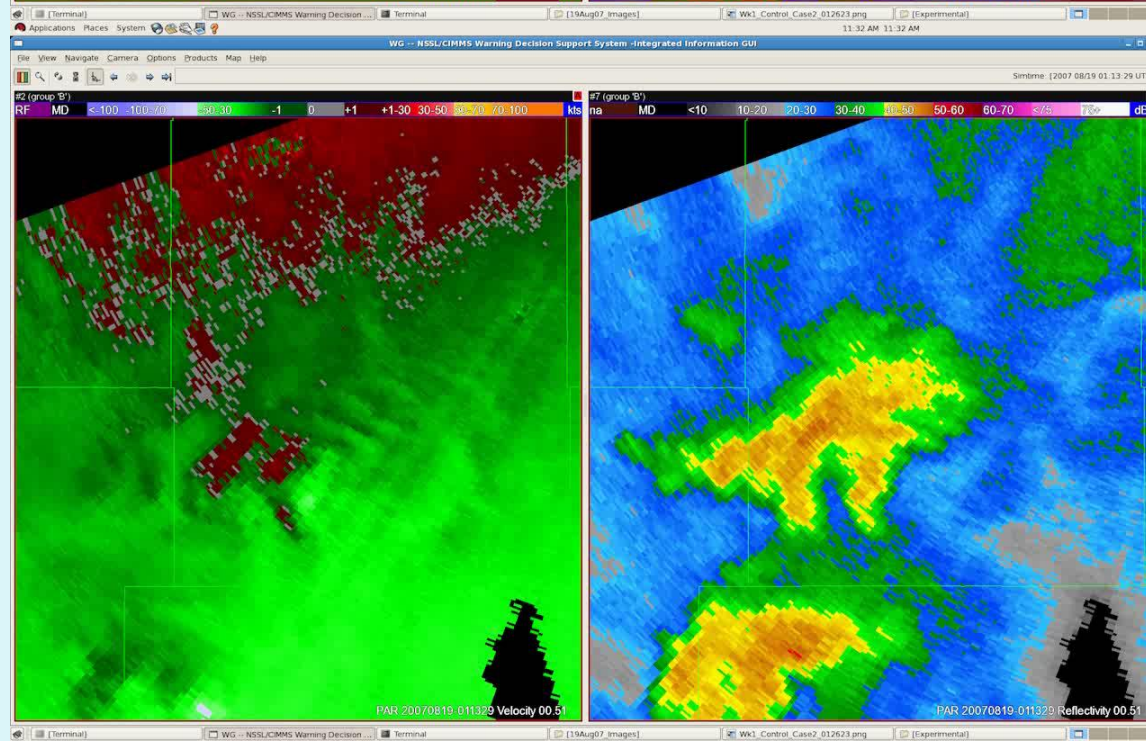


19 Aug 2007

43-s  
Updates



4.5-min  
Updates



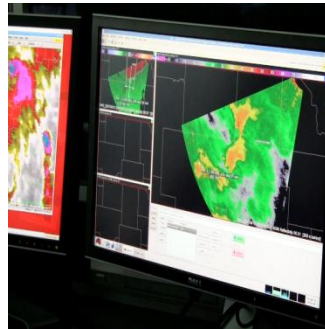


# Data Collected

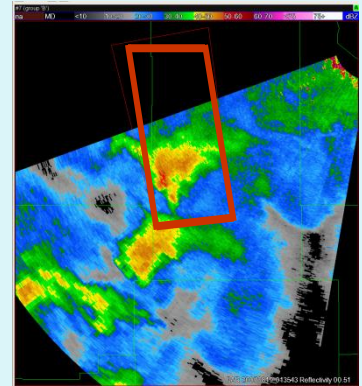
What they did



Audio of the teams working through situation awareness and the case



Video of computer screens



Products issued

What we saw



Two observers took notes in each room



# Data Collected

What they thought they did



Teams debriefed individually



Joint debrief to compare across teams



Each individual ranked factors in their warning decision

How confident were you in your understanding of what was happening in this particular event?

Less Confident ← Usual Confidence → More Confident

How confident were you about what you saw in PAR data?

Less Confident ← Usual Confidence → More Confident

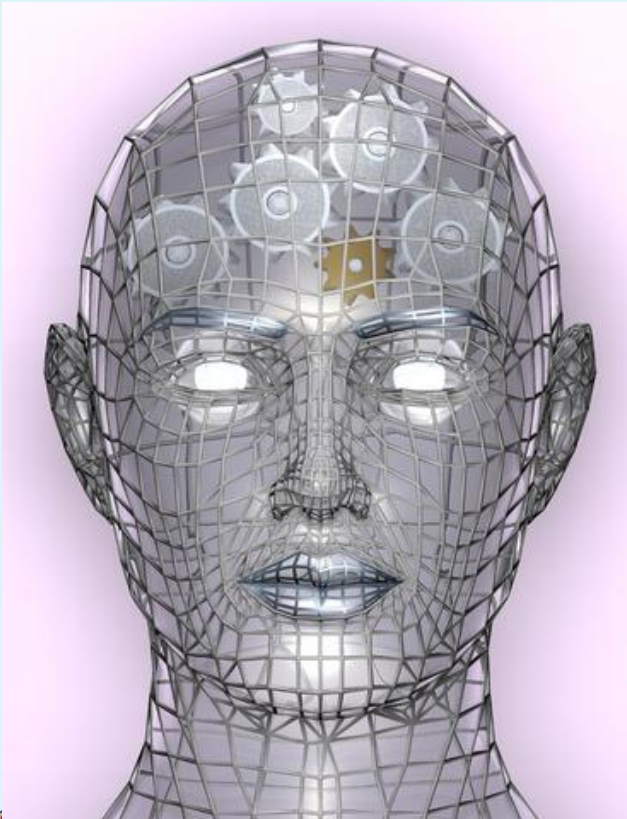
What made you feel the most confident in your warning decision?

Each individual completed a confidence continuum

# Understanding Decision Process

## Coding and Thematic Analysis

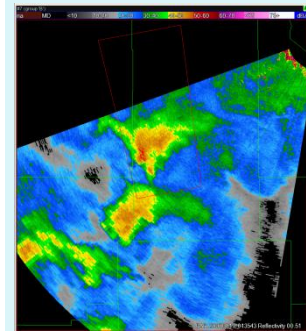
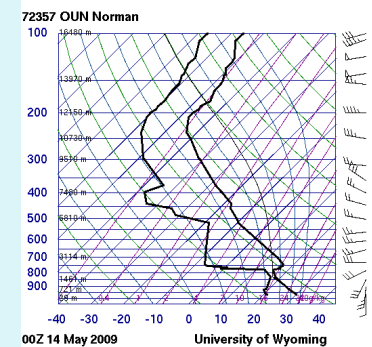
### Cognitive Actions



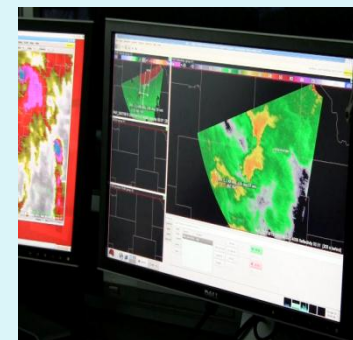
### Emotions



### Data used



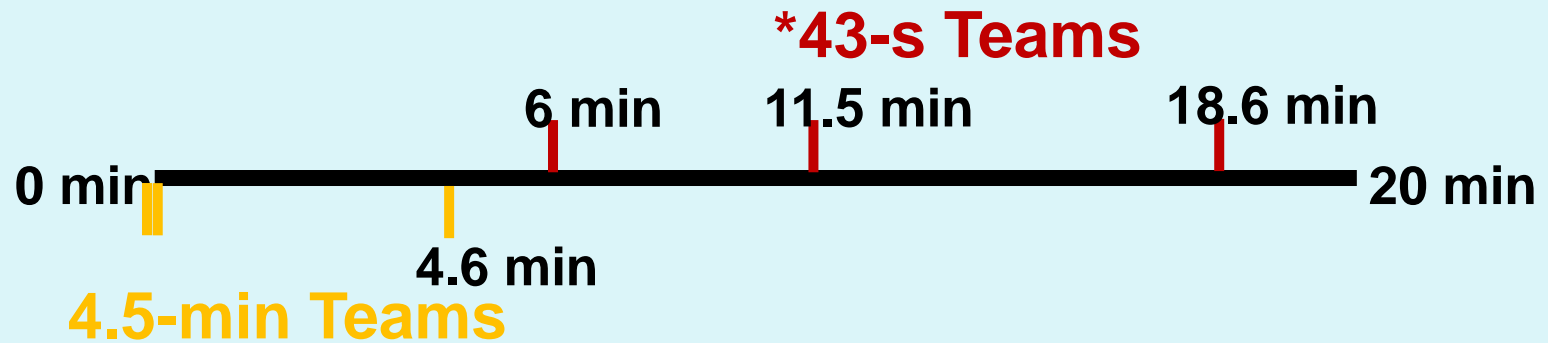
### Experiment Design & Software



# What we've learned

- 6 teams interrogated similar radar signatures, but came to different conclusions about whether and when to warn.
- Update time likely had a positive impact on warning lead time.

## Warning Lead Times



\*Issued 50% more warnings: 3 hits, 1 miss, 2 false alarms

- This type of data analysis is time-intensive!

# 2012 PARISE



*“When will I get this  
radar data in my office?”*

NWS Forecaster

*More direct data collection methods?  
Are these results repeatable?  
What about null cases?*



Scientist

**Wednesday April 3, 03:30-03:50 pm**

Verification of Simulated NWS Tornado Warnings During  
PARISE 2012

*(Pam Heinselman, NSSL)*





# Looking Forward

HWT in 2013 and Beyond



# HWT 2013 – Ready to Go

- Spring Experiment 2013
  - EWP: May 6-24 (reduced length due to funding/travel constraints).
  - EFP: May 6-June 14.
  - Better interaction between “F” side and “W” side (like SPC to WFO).
- PARISE 2013
  - Research Question: What effect does higher-temporal resolution data have on the warning decision process during **microburst events**?
  - 12 participants, 2 NWS WFOs.
  - 6 weeks during spring/summer 2013.



# HWT 2013 – Under Development

- Next-Gen warning concepts (FACETs).
  - Grid-based probabilistic threat forecasting and communication.
  - See Rothfusz et al. poster tomorrow.
- SocSci & Weather Workshop
  - Goal: Identify/Prioritize SocSci research questions in the warning system.
  - Social scientist immersion in warning ops.
  - Tentative October 2013.
- Winter Wx Experiment
  - Dual pol signatures.
  - Validation of the surface precip type.
  - Very short range prediction.



# HWT Future View

- Year-round, more diverse activities (e.g., hydro, winter, fire, SocSci, etc.).
- Blur the distinctions between EWP and EFP in HWT.
  - Consistent with FACETs' continuum approach.
- Collaborate more effectively with AWIPS-II developers (GSD, MDL, etc.).
- Clarify relationship(s) between HWT and OPG.
- Infomercial: Impressive and available resources in the HWT.
  - AWIPS-II workstations.
  - Inquisitive, interested severe weather experts all quads.
  - Need to test a high-impact weather idea, application, or theory?  
Let's talk!



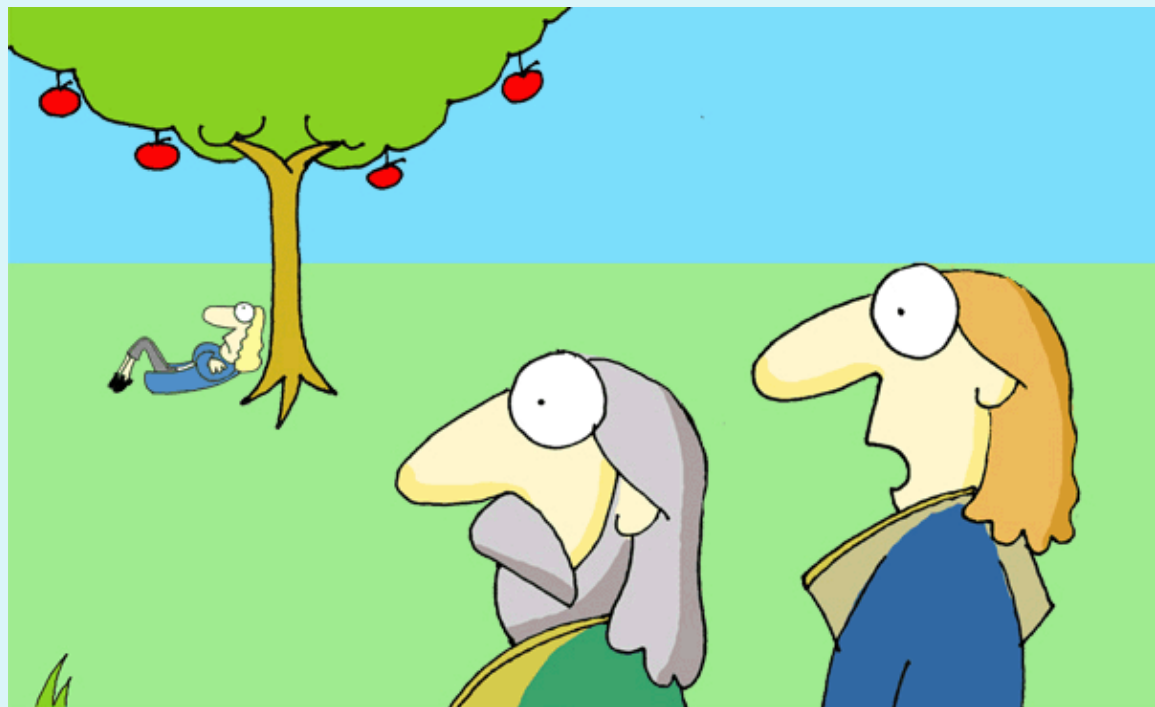


# Comments and/or Questions?

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“Reviewers have asked him to reproduce the experiment.”